Evaluation Report: HP StoreFabric SN1000E 16Gb Fibre Channel HBA

Evaluation report prepared under contract with HP

Executive Summary

The computing industry is experiencing an increasing demand for storage performance and bandwidth due to increases in virtual machine density, increasing demands for application performance and continual data growth. Fibre Channel storage area networks (SANs) carry the bulk of storage traffic in the enterprise data center and are beginning to feel the stresses of these increased demands.

In many cases, enterprises are currently constrained by the available bandwidth between the servers and storage, or foresee a constraint as they observe their growing data consumption patterns. Based on the latest Gen 5 (16Gb) Fibre Channel technology, the HP StoreFabric SN1000E 16Gb Fibre Channel (16GFC) host bus adapter (HBA) addresses these increasing demands on storage performance by providing double the bandwidth of previous generation Fibre Channel HBAs.

Demartek deployed an HP ProLiant DL380 Gen8 Server with the HP StoreFabric SN1000E 16GFC HBA and connected this server to an HP StoreServ Storage 7450 all-flash array with four 8GFC host ports. We ran a read-intensive data warehouse workload based on the TPC Benchmark™[1] standard to determine whether this type of workload could take advantage of the increased bandwidth and performance that Gen 5 Fibre Channel provides. We repeated the database workload test with a previous-generation HP StoreFabric 82E 8Gb Fibre Channel HBA and compared the results.

Key Findings

We found that, for the database workload used in testing, the HP StoreFabric SN1000E 16GFC HBA exceeded the performance of the 8Gb Fibre Channel HBA and provided the additional bandwidth needed by the database workload to complete the job in significantly less time.

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[1] See Test Description and Environment for additional details. The Transaction Processing Performance Council (TPC) defines transaction processing and database benchmarks including the TPC-H benchmark specification but was not involved in this study. Additional information about this standard is available at: www.tpc.org/tpch

HP StoreFabric SN1000E 16GFC HBA results:

- The real database workload was completed up to 26% faster than the 8Gb FC HBA, reducing the time to complete the 6-user workload by approximately one hour.
- Provided 2x peak throughput compared to the 8Gb FC HBA.
- Reduced latency by more than 50%.
- HP StoreFabric SN1000E 16GFC HBAs provide a simple, plug-and-play performance upgrade for the replacement of older 4Gb and 8Gb HBAs.

The Need for More Bandwidth

Today's datacenters face a variety of challenges brought on by seemingly insatiable demands on server and storage infrastructure. At the same time, new technologies are being introduced that offer both challenges and possible solutions to meet these growing challenges.

The following is a summary of factors that Demartek has identified as driving the need for more storage networking bandwidth as provided by Gen 5 Fibre Channel adapters such as HP StoreFabric SN1000E 16GFC HBAs.

VM Density

When Demartek presents next-generation storage networking technologies at various end-user industry events, we usually ask the primarily technical audience a few questions about their environments. Among the responses are that VM density has been increasing over the last few years, with higher numbers of guest operating systems running on one physical server than in the past. We expect this trend to continue.

8Gb Fibre Channel Saturation

During the last 12-18 months, when we asked the end-users in our audiences about saturation of Fibre Channel links, we consistently heard from a few users who indicated that they had saturated their 8Gb Fibre Channel links and needed something faster. The applications consistently identified as needing this higher bandwidth were database applications, regardless of the brand of database. These include single database instances running on physical hardware, multiple database instances running on physical hardware and multiple database instances running in virtual machines (VMs). These users are

generally looking for something compatible with their existing infrastructure but that provides higher bandwidth to meet their growing demands.

SSD Technology

Solid State Disk (SSD) technology is another driver of bandwidth growth. Although relatively early in the deployment cycles, we have found that those who deploy any form of SSD technology in the enterprise have experienced significant storage performance improvements. Many of these SSD deployments are in SAN environments, which drive up storage networking bandwidth consumption. Based on comments from users and many of the tests we have performed in our own lab, we have concluded that faster storage networking technology such as Gen 5 Fibre Channel—including the HP StoreFabric SN1000E 16GFC HBA—is well-suited to SSD technology.

New HP Servers

In March 2012, HP introduced HP ProLiant Gen 8 Servers that support the newest Intel® Xeon® E5-2600 processors ("Romley") and PCI Express (PCIe) 3.0. In May 2012, HP extended this server family with the introduction of servers featuring Intel® Xeon® E5-4600 processors. These servers provide not only higher numbers of cores and performance improvements in processor power but also provide significant increases in I/O throughput.

PCIe 3.0 doubles the maximum possible I/O rates to 1 GBps (gigabyte per second) per lane from the previous generation. PCIe 3.0 also doubles the maximum number of lanes available up to 40 PCIe lanes per processor as compared to the previous generation. As a result, the total I/O bandwidth available in one of these new servers is approximately quadruple that of the previous generation of servers.

Microsoft Windows Server 2012 and Hyper-V

Microsoft® Windows Server 2012 with Hyper-V was recently released, and it also addresses growing demands on computing infrastructure. Windows Server 2012 Hyper-V supports 320 logical processors and 4 TB of physical memory. It also supports 64 virtual processors, along with 1 TB of memory per virtual machine, enabling virtualization environments not previously possible. When coupled with today's newer server hardware environments and new technologies such as Gen 5 Fibre Channel, much heavier workloads can now be supported using Hyper-V.

A new feature for Windows Server 2012 Hyper-V is the support for virtual Fibre Channel, also known as Synthetic FC. This allows guest VMs to connect directly to Fibre Channel storage LUNs, allowing guests to take advantage of existing Fibre Channel infrastructure. This includes the ability for guest operating systems to be clustered over Fibre Channel. In order to take advantage of this feature, newer FC HBAs that support virtual Fibre Channel are required. HP StoreFabric SN1000E 16GFC HBAs support this feature and provide up to four virtual Fibre Channel ports per VM.

Also required for virtual Fibre Channel is N_Port Virtualization (NPIV) in the switch and HBA, which is supported by HP StoreFabric SN1000E 16GFC HBA. Hyper-V in Windows Server 2012 supports the use of multi-path I/O (MPIO) and virtual SANs, both of which are also supported by HP StoreFabric SN1000E 16GFC HBAs.

Bandwidth Growth Summary

When we discuss storage networks with enterprise users, we find that Fibre Channel is still the dominant storage interface in large-scale data centers, and is expected to remain dominant as a SAN interface for the foreseeable future.

When using storage-intensive applications like backup/restore, database transactions, virtualization and rich media, there is clearly a need for higher storage networking bandwidth and performance. The improved I/O performance of Gen 5 Fibre Channel enables faster storage and retrieval of data. For those enterprises that don't believe that they need this higher performance yet, now is the time to start planning for these eventualities, making HP StoreFabric SN1000E 16GFC HBAs a solid choice.

HP StoreFabric SN1000E Series

Technology advances including the HP StoreFabric SN1000E series of 16Gb Fibre Channel HBAs can help address growing constraints on current server and storage infrastructure.

Whether the environment includes mission-critical standalone database workloads or increasing numbers of VMs running on a single server, HP StoreFabric SN1000E 16Gb HBAs enable higher workloads and more applications and VMs to run on a single server and port, resulting in reduced cabling and higher return on IT investment.

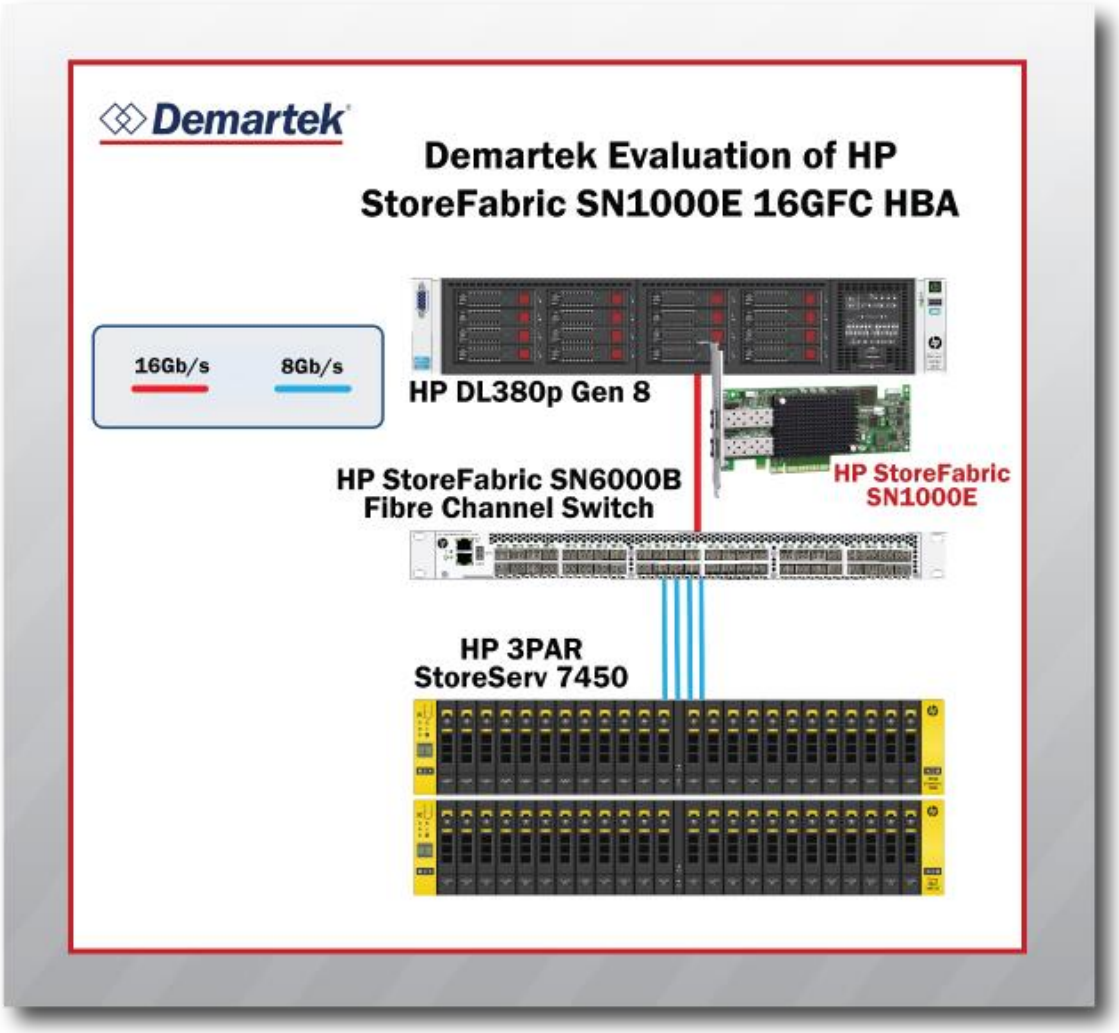
The HP StoreFabric SN1000E series of Fibre Channel adapters provide several features designed for supporting growing enterprise I/O workloads:

- Twice the performance of 8Gb Fibre Channel adapters
- Backward compatibility with 4 Gb and 8Gb Fibre Channel infrastructure
- Support for Microsoft Windows Server 2008 and 2012 (with and without Hyper-V), VMware ESX and ESXi Server, Red Hat Linux and SUSE Linux Enterprise Server (SLES)
- In-box drivers for Windows Server 2012 and VMware vSphere 5.1
- NPIV support standard
- An HP-branded solution which has undergone extensive HP interoperability testing for connecting HP ProLiant servers in storage and networking environments

Test Description and Environment

Demartek ran a read-intensive data warehouse workload with the configuration shown below. For these tests, we ran the TPC Benchmark™ H (TPC-H), which was used to generate a real-world workload, but not for the purpose of publishing official benchmark results. TPC-H is an industry-standard, decision-support benchmark that simulates broad business intelligence database environments most relevant to information systems that provide organizations with answers to critical business analytics. This test was run with the Gen 5 (16Gb) HP StoreFabric SN1000E Fibre Channel HBA running at 16Gb/sec. The test was repeated with the 8Gb HP StoreFabric 82E Fibre Channel HBA.

This test configuration was connected to an HP 3PAR StoreServ Storage 7450 all-flash array, which was configured with SSDs, making an excellent storage platform for this test.



Server

- HP ProLiant DL380p Gen8 Server
- 2x Intel® Xeon® E5-2690, 2.9GHz, 16 total cores, 32 logical processors
- 32GB RAM
- Boot drive: HP 600GB 10K RPM SAS HDD
- Microsoft Windows Server 2012

Fibre Channel HBA

- HP StoreFabric SN1000E 16Gb FC HBA (Emulex LPe16002)
- HP StoreFabric 82E 8Gb FC HBA (Emulex LPe12002)

Fibre Channel Switch

- Brocade 6510 16Gb FC SAN Switch, sold by HP as the HP StoreFabric SN6000B 16Gb Fibre Channel Switch

Storage Array

- HP 3PAR StoreServ 7450 Storage
- 48x 400GB 6Gb SAS SSD
  - RAID5 configuration for database volumes
  - RAID10 configuration for log volumes
- 4x 8GFC host ports

Note: HP 3PAR StoreServ 7000 and StoreServ 10000 Storage arrays currently use Emulex quad-port 8GFC HBAs, configured in target mode.

Data Warehouse Workload and Performance Results

Database Workload

The read-intensive database workload used consisted of a suite of business-oriented, ad-hoc queries and concurrent data modifications. The queries and the data populating the database were chosen to have broad, industry-wide relevance.

This particular workload consisted of 22 different queries, each exercising a different area of the database. The workload ran the same queries in the same order for each run, with a lower elapsed time for each query indicating a faster system. This benchmark illustrates decision support systems that examine large volumes of data, execute queries with a high degree of complexity, and give answers to critical business questions.

Real vs. Synthetic Workloads

The workload employed in this test used a real database (Microsoft SQL Server) with database tables, indexes, etc., performing actual database transactions. When using real database workloads, I/O rate will vary as the workload progresses because the database performs operations that consume varying amounts of CPU and memory resources in addition to I/O resources. These results more closely resemble a real customer environment.

This is unlike benchmarks that use synthetic workloads that perform the same I/O operations repeatedly, resulting in relatively steady I/O rates which, although potentially faster, do not resemble real customer environments.

Hardware and Software Specifications

The specifications for the software used for this test are listed below. The RAM allocated to the database application was limited to 8Gb in order to force the I/O through the Fibre Channel HBAs and out to the storage system with minimal host memory caching.

Database

- Microsoft SQL Server 2012
- RAM allocated to SQL Server: 8Gb
- Database size: 300 GB
- Total size of all database files: 600 GB

The server was rebooted between runs to clear any host memory caching.

Bandwidth Results

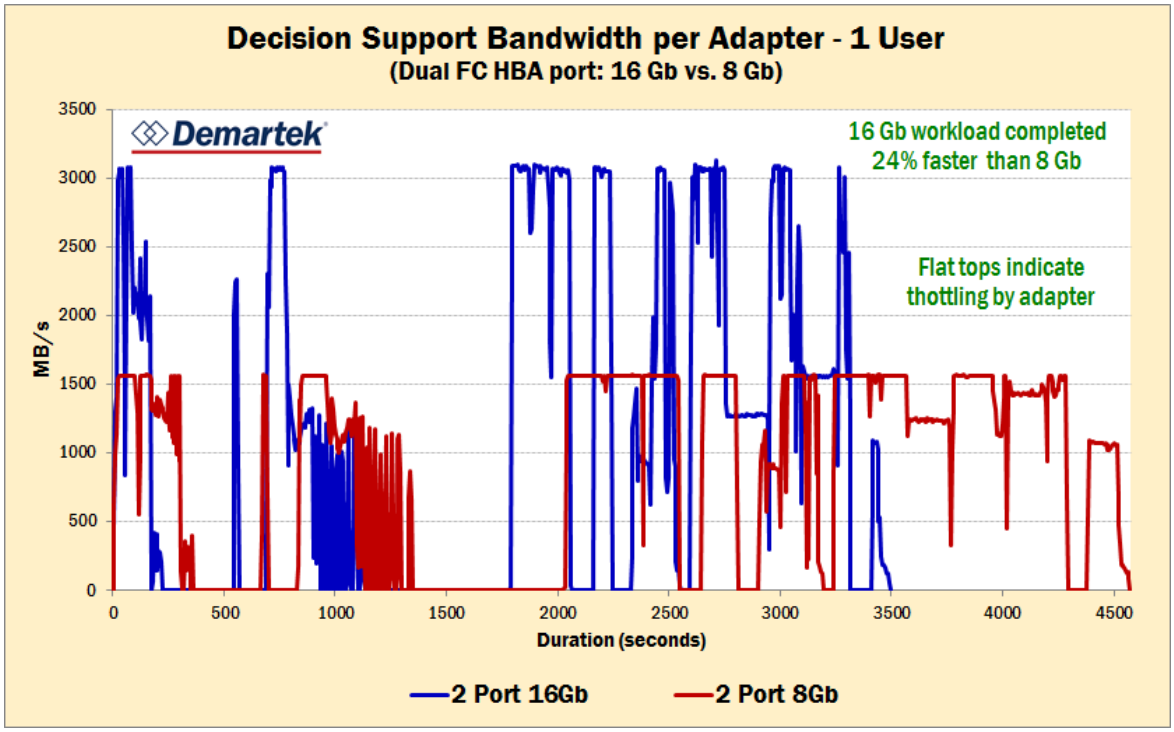
For this set of tests, Demartek used a dual-port host connection to the SAN. Two runs were performed with this workload. One run used a single database user, and the other run used six (6) database users.

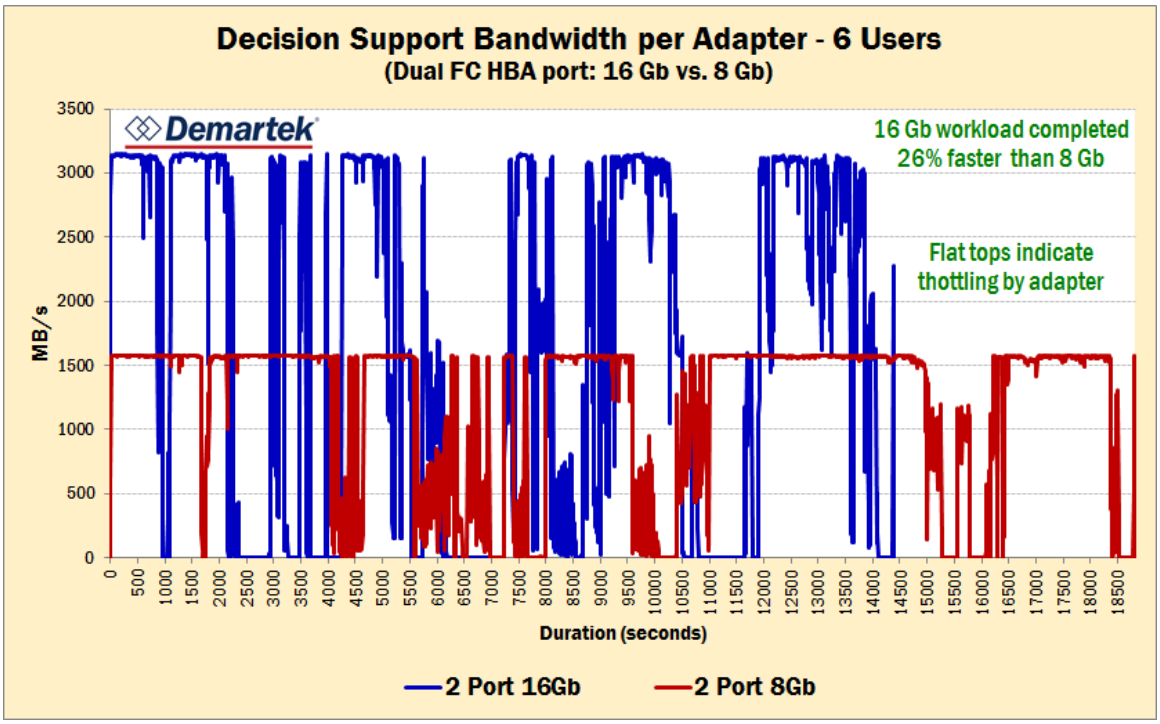
This data warehouse workload was able to achieve full line rate bandwidth with the 8Gb adapter for some of the queries. In some cases, near line-rate was achieved with the HP StoreFabric SN1000E 16Gb FC HBA adapter.

In the graph below, those queries showing a "flat top" using the 8Gb adapter indicate that more performance is available, but the 8Gb adapter is throttling the performance. The 6-user workload, a heavier workload, shows more throttling with the 8Gb adapter than the single-user workload.

When running this test with the HP StoreFabric SN1000E 16Gb FC HBA, the time to complete the run was 76% of the time required by the 8Gb adapter, or 24% faster, for the single-user run and 26% faster for the 6-user run. This reduced the time to complete the 6-user workload by approximately one hour.

For many database workloads, time to complete the work is critical because this improvement compounds with more users and more transactions. In large environment, these time reductions can lead to many hours saved.

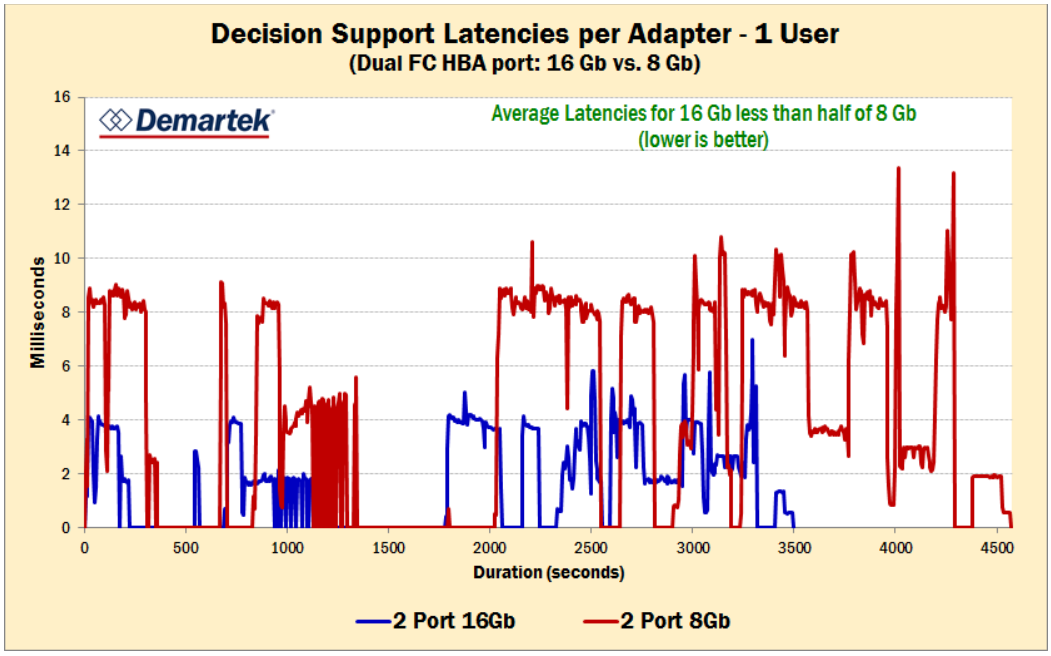

Decision Support Bandwidth per Adapter - 1 User
(Dual FC HBA port: 16 Gb vs. 8 Gb)
Demartek
16 Gb workload completed
24% faster than 8 Gb
Flat tops indicate
thottling by adapter
MB/s
Duration (seconds)
2 Port 16Gb
2 Port 8Gb

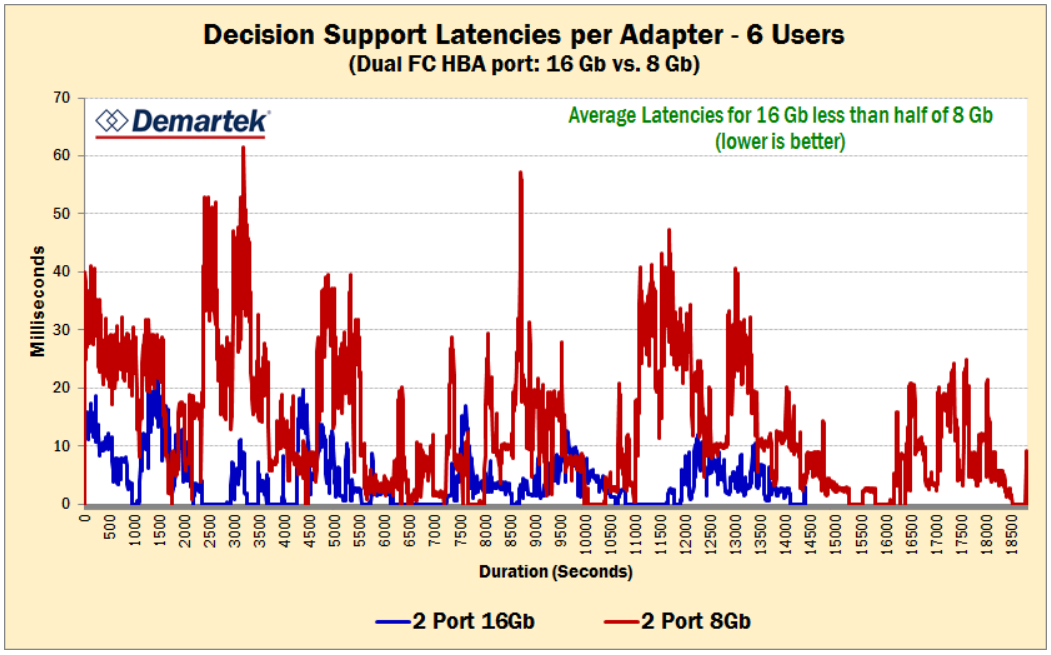

Decision Support Bandwidth per Adapter - 6 Users
(Dual FC HBA port: 16 Gb vs. 8 Gb)
Demartek
16 Gb workload completed
26% faster than 8 Gb
Flat tops indicate
thottling by adapter
MB/s
Duration (seconds)
2 Port 16Gb
2 Port 8Gb

Latency Results

The HP StoreFabric SN1000E 16Gb FC HBA provided on average more than 50% reduction in latency for this workload compared to the 8Gb adapter.

Note that the latency pattern is similar between the workloads, with the exception that the workload running with the 16Gb adapter completed the work in less time, as described above.





Summary and Conclusion

With the availability of HP StoreFabric SN1000E 16Gb PCIe 3.0 Fibre Channel HBAs, environments with growing performance requirements due to virtualized servers, database applications, SSDs, flash caching and other factors have an excellent choice in Gen 5 Fibre Channel HBA.

The results of the database workload tests using the HP SN1000E 16Gb FC HBA were able to achieve higher performance than the same server and storage configuration and workload using 8Gb FC HBAs, completing the workload up to 26% faster and with an average reduction in latency of more than 50%. Testing revealed that 8Gb FC HBAs throttle the performance and cause applications to run longer than necessary. HP StoreFabric SN1000E 16Gb HBAs enable the doubling of throughput when needed, alleviating bottlenecks under peak workload scenarios.

Gen 5 Fibre Channel provides the performance horsepower for both new environments and existing environments that demand higher performance than are available today with older technologies. For existing environments with 4Gb or 8Gb HBAs, installing HP StoreFabric SN1000E HBAs provides a simple plug-and-play performance upgrade.

The original version of this document is available at:
http://www.demartek.com/Demartek_HP_StoreFabric_SN1000E_16GFC_HBA_Evaluation_2013-08.html.